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Is distance from night penning areas an effective proxy to estimate sheep stocking density at grazing? A new methodology experienced in the Western Italian Alps

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Grazing livestock is a useful tool for the implementation of management strategies addressed to the restoration, improvement, or maintenance of grassland vegetation. Many studies aiming at assessing the effectiveness of such strategies were based on indirect measures (proxies) of stocking density exerted by livestock, such as distance from congregation areas (e.g. sheds, water sources). However, the suitability of these proxies has been rarely validated. In the Alps, sheep flocks are usually managed through lenient supervision by shepherds during day and sheltered in temporary night penning areas (TNPA) periodically moved over the grazing area. The aim of our study was to implement a method using a GPS/GIS assessment to determine whether the distance from TNPA can be used as a reliable predictor of sheep stocking density at grazing. In 2015, a flock of 250 sheep grazed for one month over 45 ha of nutrient-poor dry grasslands in the Western Italian Alps and was fenced in TNPA for 2-3 nights each. Ten sheep were tracked at 15-minute intervals with GPS collars. We assessed sheep stocking density as the number of GPS fixes within a 30 m-buffered zone around 65 randomly-generated points. We performed a linear regression analysis using stocking density within each buffered zone as response variable and the sum of inverse distances of each point from all the TNPA as explanatory. Our results highlighted a strong inverse correlation ($P < 0.001$, $R^2 = 0.83$) between the stocking density and the distance from TNPA. This short-term experiment supported the use of the distance from congregation areas as an easy-measurable and effective proxy to predict sheep stocking density in mountain environments.